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HEARTBEAT MONITORING SYSTEM USING IoT : A REVIEW

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*Abstract :*People in developing nations like India are increasingly being compelled to look for novel approaches to the ongoing monitoring of health examinations. It has become necessary to frequently travel to hospitals for doctor appointments, which is expensive and time-consuming. We suggest a concept for keeping track of the patient's health circumstances, such as heartbeats sent to a webserver via an IOT device, in order to solve this problem. The internet of things (IoT), a recent innovation that connects all devices, is seen as the next technological revolution. Patient monitoring is one of the IoT applications that keeps tabs on a patient's health. Real-time health monitoring made possible by the Internet of Things increases the effectiveness of medical devices. With the use of IoT, the doctor can access the patient's history that is maintained on the web server while also continuously monitoring the patient's condition on his smartphone.

IndexTerms **- INTERNET OF THINGS, HEART RATE MONITORING , PULSE SENSOR , ARDUINO UNO , ARDUINO SOFTWARE ,MONITOR.**

I. INTRODUCTION

In recent years, the Internet of Things (IoT) has developed into a technology that is changing the game and transforming many aspects of our lives. By enabling real-time data analysis, remote patient monitoring, and individualized healthcare solutions, IoT integration has substantially enhanced the healthcare sector. checking the heart rate is a crucial marker that provides crucial hints regarding a person's cardiovascular health.The Internet of Things and heart rate monitoring have combined to create new prospects for earlier detection, preventive care, and improved healing.

Heart disease remains the leading cause of death in the world, necessitating effective and continuous cardiac health monitoring. In therapeutic settings, electrocardiograms (ECGs), a conventional method of heart rate monitoring, are routinely used. However, the fact that these technologies typically need personal visits limits the capacity of healthcare facilities to provide real-time monitoring or to assist patients with chronic diseases or those who live in remote locations. IoT-based heart rate monitoring devices have become a viable solution that delivers continuous, remote, and non-invasive monitoring in order to get over these limitations.

IoT-based heart rate monitoring systems use connected devices like wearable sensors, smartphones, and cloud platforms to collect, send, and analyze heart rate data in real time. These systems offer a number of advantages, including improved patient involvement, accessibility, and ease. By wirelessly transmitting data to medical professionals or caregivers, IoT-enabled devices empower individuals to actively manage their own healthcare. This enables early anomaly discovery, prompt treatments, and improved treatment outcomes.

IoT-based heart rate monitoring solutions give patients more autonomy and control over their health. Real-time monitoring, user-friendly interfaces, and individualized feedback enable people to make well-informed decisions about their lifestyle selections, medication adherence, and general well-being. Furthermore, the capacity to remotely exchange heart rate data with medical professionals encourages telemedicine, easing the burden on healthcare infrastructure and enhancing patient convenience, especially for those with limited mobility or residing in rural areas.

One of the most crucial parts of the human body is the heart. It serves as a pump to distribute blood and oxygen throughout the body, maintaining the body's functionality. The two-part pumping motion of the heart that lasts for almost a second is known as a heartbeat. It is created as a result of cardiac contraction. The SA(Sino Atrial) node releases an electrical signal when blood builds up in the upper chambers, which in turn causes the atria to contract. The diastole phase of the pumping mechanism occurs when the contraction forces the blood through the tricuspid and mitral valves. When the ventricles are fully filled with blood, the next stage begins.

II. LITERATURE SURVEY :

R. Kumar et al[1] There are two methods for gaining access to the output after connecting these sensors to the Raspberry Pi board. One has output on the monitor screen and is directly connected to the Raspberry Pi board through a monitor, keyboard, and mouse. The Raspberry Pi board can also be linked to a laptop or PC using a data connection. Install Putty software on the relevant system next .Change the system's gateway, IP address, and subnet mask. Open the putty program, and the output will appear on the screen.

Dr .A .A .Gurjar et al[2] Our risk of heart attacks has grown recently. This device uses heartbeat sensing to assist in determining a person's heart rate, even when they are at home. This technology aids in hospital monitoring, with each patient being watched after by a single worker in the server room. This device aids in measuring a person's heart rate, pulse, and body temperature. In order to save animals, we shall create this system. If this technology advances, our project will be able to use it to identify heart blockages.

Ms. M R Desai et al[3] project has been successfully implemented, and as intended, it detects CO2 and other flammable gases, displays the precise ambient temperature, and additionally . It displays a person's pulse rate and takes their body temperature before sending the information or message to the appropriate party. It accurately measures human heartbeat as well, and it has a lot of potential in the near future. It can be used for gas detection in workplaces, factories, airports, healthcare facilities, and other settings where people check their health, such as hospitals.

Al Ansari et al.[4] The study's findings broaden understanding of the Internet of Things (IoT), raise awareness of IoT innovation in the healthcare industry, and encourage the use of new technologies in accordance with criteria for sustainable development. Due to the limited experience with IoT applications in the health industry, there are several limitations to this study. This may affect the investment incentive based on the stated priority, which The Rise of Internet of Things (IoT) in Big Healthcare .Technical and economic feasibility assessments seem to be necessary in 683. Additionally, governments continue to be against IoT governance, regulation, and rights of producers and consumers. Therefore, it might be a topic for future research on IoT deployment.

Teemu H. Laine et al[5] In order to use Bluetooth to connect a body area network and the internet, we have presented a mobile gateway and the U-Healthcarystem. The necessity for remote health care and wellness services for monitoring in informal settings and rural environments led to the need for such a system. Such mobile healthcare services are made possible by light-weight wireless sensors. The system becomes really omnipresent when it is augmented with a mobile gateway since sensed data may be gathered, processed, and distributed in real time regardless of place and time. The suggested mobile gateway enables patients to view current or historical vital signs on a graphical interface, manage sensor nodes, and interact with medical providers. Comparing Bluetooth to ZigBee, a faster data rate is possible. Large amounts of sensed data can be exchanged between sink nodes and the mobile gateway since Bluetooth offers a quicker data rate than the ZigBee protocol. The suggested system solves the issues in earlier ubiquitous health care systems with single-point data aggregation (just Bluetooth) and sluggish transmission from a sink node to a gateway by integrating Bluetooth with a ZigBee-based BAN (only ZigBee). Additionally, the suggested gateway's adaptable design permits its application in any circumstance where ZigBee-based BANs demand a mobile gateway.

Ruhani Ab. Rahman et al[6] According to the findings, it is reasonable to infer that diabetic patients can accurately assess their breath acetone levels to determine their blood ketone (-hydroxybutyrate) levels. This is because there is a strong association between breath acetone levels and blood ketone levels. The Internet of Things' functionality can be used by the real-time diabetic condition monitoring system to function (IoT). It has been proven that online databases used for personal diabetes monitoring are effective. The test findings demonstrate that it is possible to measure the amount of breath acetone in order to monitor the ketone levels. A more effective sensor calibration technique can increase the system's accuracy.

Rajan Merchant et al[7] This investigation showed that digital health treatments can be included into standard clinical practise and that doing so may improve outcomes, such as lowering the need for medical care and SABA use. The data gathered by the EMMs, shared with patients and HCPs, can enhance personalised clinical care and encourage self-management to improve asthma outcomes.

Vivek Pardeshi et al[8] In this research, we examined an Internet of Things (IoT)-based Raspberry Pi health monitoring system. Through GSM technology or the internet, the specific person can be directly informed of any irregularities in their health circumstances. The suggested system is straightforward, energy-efficient, and simple to comprehend. It serves as a conduit between the patient and the physician .The project's hardware has been put into place, and the output results have been satisfactorily confirmed.

M. Mamun-Ibn-Abdullah et al[9] This study presents an Internet of Things-based healthcare platform that communicates with smart sensors placed to people's bodies to monitor their health on a regular basis. This research project offers the chance to continuously monitor patients utilising the Thing Speak open source cloud platform with remote monitoring and mobile SMS service, which uses machine learning to differentiate between a normal and abnormal heartbeat. In addition, we identified the most effective method for disease prediction. Results reveal that SVM and Decision Tree outperform other methods in the detection of heart disease even though machine learning techniques are effective in doing so.

Ibrahim Rahamath Ullah et al[10] A unique system based on integration of contemporary technologies: software, computer, and information technologies is a real-time ECG warning system on myocardial infarction, hyperkalemia, and atrioventricular block. It is a unique piece of prototype software designed to help doctors diagnose cardiac patients more accurately with the

III. DESIGN AND METHODOLOGY:

PROPOSED METHOD : It uses internet of things-based heart rate monitoring , the suggested device is quite good at detecting heart attacks. Our method uses a pulse sensor and an Arduino board. The pulse sensor will begin detecting heart rate measures after the system is set up, and it will display the person's heartbeat on an LCD screen. An individual's heartbeat can be compared to a predefined point in the system to ascertain their level of health. The device will start monitoring the patient's heart rate as soon as these parameters are set. The device will instantly transmit a warning message if the heart rate departs from the set range.

BACKGROUND STUDY : The centre of the human body is the heart. It is in charge of the blood's distribution throughout the body. Heart rate, or HR, is the pace at which the heart beats and is impacted by the artery wall's development with each beat. The wrist (Radial artery), neck (Carotid artery), inside elbow (Brachial artery), knee (Popliteal artery), and ankle joint (Posterior artery) are the pulse locations that are most noticeable.The HR varies according to the body's physical and psychological affects as well as the era. An increased pulse rate indicates an anomaly in the body, which can also be brought on by other conditions like heart illness, worry, fury, excitement, or emotion. Although a person's pulse rate can be useful in identifying certain health issues, it cannot be utilized exclusively to identify an anomaly.Sedentary women and men typically have average heart rates of 80 and 72 beats per minute, respectively, although skilled athletes frequently have much higher heart rates. The following Table describes the respiratory and cardiac rates for various age groups.

AGE	HEART BEAT (BPM)	RESPIRATORY RATE
0 – 5 months	90-150	25-40
9 - 12 months	80-140	20-30
1 – 3 years	80-130	20-30
3 – 5 years	30-120	20-30
6 – 10 years	70-110	15-30
11 – 14 years	60-105	12-20
14 + years	60-100	12-20

TABLE : HEART RATE AND RESPIRATORY RATE FOR DIFFERERENT AGES

SYSTEM ARCHITECTURE : The internet of things project's patient monitoring system uses internet connectivity to send the health data of its patients' pulse rates to the cloud. An Arduino UNO is linked to a Wi-Fi module in order to create an Internet of Things heart rate monitoring system, which requires a Wi-Fi connection. The wireless network connection in this system is configured using an ESP8266 wi fi module.

IMPLEMENTATION :

A . ESP8266 Node MCU Board :

The ESP8266 Node MCU CP2102 board has ESP8266 which is a highly integrated chip designed for the needs of a new connected world. It offers a complete and self-contained Wi-Fi networking solution, allowing it to either host the application or to offload all Wi-Fi networking functions from another application processor.ESP8266 has powerful on-board processing and storage capabilities that allow it to be integrated with the sensors and other application-specific devices through its GPIOs with minimal development up-front and minimal loading during runtime. Its high degree of on-chip integration allows for minimal external circuitry, and the entire solution, including the front-end module, is designed to occupy minimal PCB area.

The ESP8266 Node MCU development board – a true plug-and-play solution for inexpensive projects using Wi Fi. The module arrives pre-flashed with Node MCU firmware so they're ready to go – just install your USB driver (below). ESP-12 Lua Node mcu WIFI Dev Board Internet Of Things board contains a full ESP8266 Wi Fi module with all the GPIO broken out, a full USB-serial interface, and a power supply all on the one breadboard-friendly package.

This board is pre-flashed with Node MCU – a Lua-based firmware for the ESP8266 which allows easy control via a neat scripting language – Lua – so you're ready to go in just a few minutes.

The ESP-12 Lua Node MCU WIFI Dev Board Internet Of Things with ESP8266 is an all-in-one microcontroller + Wi Fi platform that is very easy to use to create projects with Wi Fi and IoT (Internet of Things) applications.

The board is based on the highly popular ESP8266 WiFi Module chip with the ESP-12 SMD footprint. This Wi Fi development board already embeds in its board all the necessary components for the ESP8266 (ESP-12E) to program and upload code. It has a built-in USB to serial chip upload codes, 3.3V regulator, and logic level converter circuit so you can immediately upload codes and connect your circuits.

B. Pulse Sensor:

A pulse wave is the change in the volume of a blood vessel that occurs when the heart pumps blood, and a detector that monitors this volume change is called a pulse sensor.

First, there are four main ways to measure heart rate: electrocardiogram, photoelectric pulse wave, blood pressure measurement, and phonocardiography . Pulse sensors use the photoelectric method.

Pulse sensors using the photoelectric pulse wave method are classified into 2 types depending on the measurement method: transmission and reflection.

Transmission types measure pulse waves by emitting red or infrared light from the body surface and detecting the change in blood flow during heart beats as a change in the amount of light transmitted through the body.

This method is limited to areas where light can easily penetrate, such as the fingertip or earlobe.

ROHM is currently developing a reflection-type pulse sensor (Optical Sensor for Heart Rate Monitor).

The reflection-type pulse sensor (Optical Sensor for Heart Rate Monitor) is explained below.

Reflection-Type Pulse Sensor (Optical Sensor for Heart Rate Monitor)

Reflection-type pulse sensors (Optical Sensors for Heart Rate Monitor) emit infrared, red, or green light (~550nm) towards the body and measure the amount of light reflected using a photodiode or phototransistor. Oxygenated haemoglobin present in the blood of the arteries has the characteristic of absorbing incident light, so by sensing the blood flow rate (change in blood vessel volume) that changes following heart contractions over time we are able to measure the pulse wave signal.

Also, since reflected light is measured, the range of suitable areas is not limited as with transmission-type pulse sensors.

Reflection-Type Pulse Sensor
(Optical Sensor for He Pulse wave measurement using red or infrared light can be affected by infrared rays contained in sunlight (i.e. outdoors), preventing stable operation. For this reason, usage indoors or semi-indoors is recommended.
For pulse wave measurement outdoors (i.e. by smart watches), a green light source which has a high absorption rate in haemoglobin and less susceptibility to ambient light is preferred, so ROHM utilizes green LEDs as transmission light sources .art Rate Monitor) - Operating Mechanism

Pulse Sensor (Optical Sensor for Heart Rate Monitor) Applications

Generally, by looking at the period of fluctuation from the waveform obtained by measurements of the pulse wave sensor and observing the pulsation (variation) using the heart rate along with both red and infrared waves, it is possible to measure the arterial blood oxygen saturation (SpO2).
In addition, using data from pulse sensors is expected to enable calculation of various vital signs such as HRV analysis (stress level) and vascular age through high-speed sampling and high accuracy measurement.

Pulse Sensor Features and Specifications
- Biometric Pulse Rate or Heart Rate detecting sensor
- Plug and Play type sensor
- Operating Voltage: +5V or +3.3V
- Current Consumption: 4mA
- Inbuilt Amplification and Noise cancellation circuit.
- Diameter: 0.625”
- Thickness: 0.125” Thick

How Pulse Sensor Works
The working of the Pulse/Heart beat sensor is very simple. The sensor has two sides, on one side the LED is placed along with an ambient light sensor and on the other side we have some circuitry. This circuitry is responsible for the amplification and noise cancellation work. The LED on the front side of the sensor is placed over a vein in our human body. This can either be your Finger tip or you ear tips, but it should be placed directly on top of a vein.
Now the LED emits light which will fall on the vein directly. The veins will have blood flow inside them only when the heart is pumping, so if we monitor the flow of blood we can monitor the heart beats as well. If the flow of blood is detected then the ambient light sensor will pick up more light since they will be reflect ted by the blood, this minor change in received light is analysed over time to determine our heart beats.

How to Use Pulse Sensor
Using the pulse sensor is straight forward, but positioning it in the right way matters. Since all the electronics on the sensor are directly exposed it is also recommended to cover the sensor with hot glue, vinyl tape or other non conductive materials. Also it is not recommended to handle these sensors with wet hands. The flat side of the sensor should be placed on top of the vein and a slight presser should be applied on top of it, normally clips or Velcro tapes are used to attain this pressure.
To use the sensor simply power it using the Vcc and ground pins, the sensor can operate both at +5V or 3.3V system. Once powered connect the Signal pin to the ADC pin of the microcontroller to monitor the change in output voltage.

METHODOLOGY OF THE SYSTEM :
In this system, hardware implementation and software implementation are interfaced to design this heart rate monitoring system based on the embedded system.

HARDWARE IMPLEMENTATION :
Firstly, the pulse sensor is attached to any organ of body where it can detect the pulse easily like finger. Then the used sensor measures the change in volume of blood, which occurs when every time blood in the body is pumped by heart. The light intensity through the organ of body changes corresponding to the change in volume of blood in that organ. The software then converts this change into beats per minute (BPM) .
Pulse sensor has three pins. Connect VCC and the ground pin of the pulse sensor to the 5V and the ground of the Arduino and the signal pin to the A0 of Arduino.
The ESP8266 communicates with the Arduino and sends the data to ThingSpeak. This data on the ThingSpeak is displayed in a graph form showing the past readings too and can be accessed from anywhere over Internet.

SOFTWARE IMPLEMENTATION :
The simulator Arduino IDE, 1.8.7 and Proteus 8 is used to implement software. Arduino IDE, 1.8.7 is used to write the Arduino c program to the Arduino UNO interface. Before the hardware circuit is implemented and this circuit is interfaced with the system software program, proteus 8 simulator is used to simulate the system layout of this interface circuit. The BPM value will show on the LCD.
Wi-Fi module's name, password and IP address and the ThingSpeak API key are mainly included in the Arduino program code for the security of that monitoring system. This system uses the user name and password for safety and API keys are required to modify the program. Arduino code is programmed to read the pulse rate and sense the pulse rate data to ThinkSpeak via ESP8266 wireless module.

THINGSPEAK :
ThingSpeak is a nice instrument and offers system equipment based on IoT. The information can be tracked and controlled via the Internet using the ThingSpeak website's channels and web pages. Firstly, a registration is needed to create a ThingSpeak account on the ThingSpeak site, https//thingspeak.com. A ThingSpeak account was created, channels were clicked. A new channel and field

name was created. Do the check mark in the check box at the bottom of the form to choose "Make public" and save the channel and generate the new channel. The new channel has been created, the API keys in ThingSpeak site. Then select the API key to duplicate the Write API key. It will be needed in the program. API keys are required to modify the program and they are necessary to set the information.

IV. RESULTS AND DISCUSSION

Hospitals and other locations where ThingSpeak is utilized employ the Heart Beat Monitoring System. The human body is connected to the pulse sensor. The pulse sensor detects variations in blood volume, making pulse detection possible. Heart beat per minute is converted by Arduino, and the text "BPM" describing heart rate is displayed on the LCD. The ESP8266 will set up with Arduino, transmit data to ThingSpeak to get the code, and display the result using the graph connected to Arduino along with the result (BPM).

It is therefore more efficient than storing the records in files on printed paper. Data loss may occur even from corrupted digital records kept on a laptop, personal computer, or memory storage device. On the other hand, this IoT-based solution has a lower possibility of data loss and is more dependable when using cloud storage. The doctors will find this proposed method quite helpful as it allows them to continuously check the patient's heart rate simply by visiting a website or URL.

There are various potential paths for more growth and development in terms of future scope:
Advanced algorithms for analysing the heart rate data can be added to the system to provide for enhanced data analysis. This could entail locating patterns, recognising irregular cardiac beats, and creating notifications for any potential health problems.
Power Optimisation: Investigating power optimisation methods, such as energy harvesting or low-power modes, would prolong the system's battery life and improve usefulness.
Wearable Design: Creating a system with a wearable form factor, like a bracelet or chest strap, would make monitoring easier and less invasive.
Integration with Other Health metrics: A more complete health monitoring system would be created by integrating heart rate monitoring with other health metrics like blood pressure, oxygen saturation, or body temperature.

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